

Evaluating the effectiveness of UV irradiation on the oral cavity in rats

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Abstract — A device for treatment various infectious diseases was developed. The device performed process of treating infected cavities. We present results of investigations of the influence of ultraviolet radiations over the bacterial strains from the oral biofilm. The purpose of the present study is experimental remodeling of the dental caries and analysing the possibilities of increasing the efficiency of preventing methods.

Index Terms — UV radiation, infectious diseases, oral biofilm, dental caries.

I. INTRODUCTION

One of the most difficult issues of the modern medicine is the combat against the infectious diseases. At the same time the problem of the increasing resistance of the infected microorganisms against the most up-to-date antibacterial preparations (the chemotherapy problem), is becoming more urgent. Because of this we proposed to develop a device for photosanitation with ultraviolet C (UVC) radiation of the human cavities populated with colonies of unspecific or/and tuberculosis microflora. The device performed process of treating infected cavities and contains: mercury tube, focusing system for selection of segment of the radiation spectral band 250-500 nm, optical guide with connectors and a puncture needle. Use the tube with high pressure mercury vapor as a radiation source allows to obtain the broadband photon radiation for treatment more efficient and for recovery time reduce. It also provides a substantial simplification of the device and reducing its costs [1]. The device was used to approve the method of treatment of infected cavities by means of endocavitary broadband irradiation. In the experiments we used cultures of *Escherichia coli* and *Candida albicans*. Effect of annihilation of bacteria colony is almost directly proportional to the duration of exposure and complete suppression occurs within 2 min [2]. Also, the efficiency of the irradiation device developed for colonies of *Mycobacterium Tuberculosis* was demonstrated [3].

II. UV IRRADIATION OF MICROBIAL CULTURES

In vitro investigations of the influence of UV radiations over the bacterial strains from the oral biofilm were conducted in "Micromed" laboratory, by applying of Vitek automatic system. The biofilm samples have been collected from 30 children presenting a high level of caries activity process. The total number of microorganisms has been approximated and the following cariogenic bacteria have been identified *Streptococcus viridans*, *Streptococcus mutans*, *Streptococcus mitis*, *Streptococcus sobrinus*, *Streptococcus gordonii*.

10 seedings have been performed from the above mentioned gathering and that way suspension were prepared by standard technologies. Petri dishes were filled

with a concentration of 10^6 microorganisms in 1 cm³ of solution. The Petri dishes thus prepared, were later exposed to UV radiation with duration of 10, 20, 30, 40 seconds and 1, 2, 3, 4, 5 min (Table 1).

Areas of 1cm² have been irradiated, leaving for comparison unexposed areas between the irradiated ones. The Petri dishes were incubated for 24 h in the thermostat at a temperature of 37°C. An optical microscope with a maximizing of x100 has been used in this research.

TABLE I. RESULTS OF UV IRRADIATION OF MICROBIAL CULTURES

No lot	No seedings	Length of UV irradiation	Initial number of microorganisms	Remaining number of microorganisms
1	10	—	10^6	10^7
2	10	10 sec	10^6	10^5
3	10	20 sec	10^6	10^3
4	10	30 sec	10^6	10^5
5	10	40 sec	10^6	10^4
6	10	1 min	10^6	10^2
7	10	2 min	10^6	—
8	10	3 min	10^6	—
9	10	4 min	10^6	—
10	10	5 min	10^6	—

III. EXPERIMENTAL REMODELING OF THE DENTAL CARIES

The experimental study has taken place in the vivarium of State Medical and Pharmaceutical University "Nicolae Testemițanu".

The purpose of the present study was experimental remodeling of the dental caries and analysing the possibilities of increasing the efficiency of preventing methods.

The experimental modeling of inducing dental caries through the influence of the most frequent risk factors (failure to respect oral hygiene and a rich consumption of refined carbohydrates) cause similar conditions to those in dental caries development to children. Analysing the results will further enable us to select the most effective methods of cario – prevention and later use them in medical studies.

According with the objectives, the following experimental model has been elaborated: 2 series of experiments over 70 rats, *Rattus norvegicus species*, WAG

(Wistar Albino Glaxo) strain aged 6-7 weeks and weighting 50-80g.

Every group of 10 rats had an equal number of female and male rats (5 – 5); that being a fair number to obtain the wanted objectives and achieve statistically significant results.

Features of the experimental series are as follows:

1st series of experiments: experimental inducing the caries process: group1: n=10, control group Wistar rats, standard diet vivarium, favoring auto-cleaning of the oral cavity; group2: n=10, Wistar rats to whom the dental caries was introduced by administrating the cariogenic diet. The study took place over a period of 60 days.

2nd series of experiments: evaluation of UV radiation efficiency. All rats (5 groups of 10 animals) have been infected with experimental dental caries, and in order to prevent the caries, the dental surfaces have been irradiated with UV rays.

Antimicrobial phototherapy has been realized using the photosanitation device of infected cavities from the human body, UVSAN, that has as radiation source the high-pressure mercury vapors tube ДПИИ – 100. The dental surface irradiation was performed at an angle of 45°, at the distance of 1 cm. The irradiation frequency was twice per week; and the length in the 3rd group was 1 min; 4th – 2 min; 5th – 3 min; 6th – 4 min; 7th – 5 min. The study was conducted for 60 days.

At the end of the experiment, the animals were killed by being administered with a lethal dose of substance for narcosis. After being declared dead by the vet, the animals have been beheaded and then their jaws were separated.

Impact of methods of inducing experimental dental caries were evaluated by means of study of dental hard tissue, described by Kolesnic and co-authors [4].

IV. SURVEY RESULTS

Microbiological analysis performed over in vitro research, has allowed us to observe the reduction of the total number of microorganisms in the cultures (gatherings) that have been UV irradiated (groups 2 – 7) in comparison to those from the first group, that has not been exposed to UV radiation.

At the same time increasing of UV radiation length, we can observe the number of microorganisms in 1 cm³ of solution from 10⁶ to 10² reducing.

As a result of UV irradiation with a duration of 2 min and more, there is bacteria annihilation (lots 7 – 10), which confirms the strong bacterial effect of UV irradiation on cariogenic microbial cultures which operates maximum production of organic acids in dental and oral biofilm.

Analysis of the experimental results enabled us to observe the impressive increase in the number of carious cavities formed and the propagation of the carious process to rats, after following the cariogenic diet (group 2).

After the UV irradiation process with an impressive decrease of intensity and depth of cariogenic process was noted (lots No.3-7).

Index of reduction in dental caries varies between 59% (lot 3) and 76%, the maximum effect being seen in lot 7

(Table 2.).

But, comparing the results of in vitro research and the experimental ones, we observe that even though after irradiation of microbial cultures from the dental biofilm with UV rays; within 2 min and more it can be seen the bactericidal effect of UV rays, cavity formation to the rats from the researched groups is reduced but could not be completely prevented.

TABLE 2. INTENSITY OF DAMAGE DENTAL CARIES AND THE DEPTH OF CARIOUS PROCESS TO RATS

No lot	No pets	Length of UV irradiation	Average nr. of carious cavities per rat	Depth of carious process
1	10	—	0,2±0,3	0,3±0,2
2	10	—	8,8±0,2	4,7±0,5
3	10	1 min	3,6±0,4	3,5±0,1
4	10	2 min	2,9±0,6	2,3±0,2
5	10	3 min	2,7±0,3	2,1±0,3
6	10	4 min	2,3±0,4	2,0±0,1
7	10	5 min	2,1±0,7	1,9±0,3

This confirms the fact that dental caries is a polyetiologic process, and administrating a rich diet in refined carbohydrates and lack of auto-cleaning of the oral cavity, has a considerable impact on the functioning of the entire body.

V. CONCLUSIONS

1. In vitro research, performed in this study proved the strong bacterial effect held by UV irradiation over cariogenic microorganisms gatherings.
2. Resulting the experiment, it was calculated the cario-preventive effect of UV irradiation of dental surfaces, and the fact that the reduction rate varies between 59% and 76%.
3. It is necessary to conduct a series of clinical trials on human volunteers to confirm the results obtained during the in vitro experiments over rats.

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